Claims

1. A magnetic resonance imaging method, comprising:

an entire image forming step of repetitively performing a unit region processing step including a unit region measuring step of measuring echo signals from a subject corresponding to a unit region having an origin of a k-space and a specific width from a low spatial frequency region to a high spatial frequency region, and a unit region image forming step of forming an image of the unit region from echo signals corresponding to the unit region, while changing an angle of rotation of the unit region about the origin of the k-space, so that an entire image is formed by fusing plural unit region images, the magnetic resonance imaging method being characterized in that, in the unit region measuring step, measurements of the echo signals are skipped in at least one unit region.

2. The magnetic resonance imaging method according to Claim 1, characterized in that:

in the unit region measuring step, a multiple receiver coil formed by combining plural receiver coil units is used to acquire echo signals at each receiver coin unit; and

in the unit region image forming step, the unit region image is formed using the echo signals at each receiver coil unit.

3. The magnetic resonance imaging method according to Claim 2, characterized in that:

in the unit region image forming step, the unit region image from which aliasing artifacts are removed is formed by using sensitivity distribution data of each receiver coil unit.

4. The magnetic resonance imaging method according to Claim 3, characterized in that:

the unit region comprises plural parallel trajectories; and

a measurement of echo signals corresponding to at least one trajectory among the parallel trajectories is skipped in the skipped measurements.

5. The magnetic resonance imaging methods according to Claims 1 through 4, characterized in that:

measurements of echo signals corresponding to the high spatial frequency region on one side of the unit region are skipped.

6. The magnetic resonance imaging method according to Claim 4, characterized in that:

the unit region processing step further includes a sensitivity distribution data generating step of generating sensitivity distribution data of each unit region and each receiver coil unit from the echo signals to correspond to the angle of rotation of the unit region and a configuration of the multiple receiver coil; and

the sensitivity distribution data generating step is performed before the unit region image forming step.

7. The magnetic resonance imaging method according to Claim 6, characterized in that:

in the sensitivity distribution data generating step, the sensitivity distribution data of each unit region and each receiver coil unit is generated independently, using the echo signals at each receiver coil unit in low spatial frequency regions of plural unit regions.

8. The magnetic resonance imaging method according to Claim 6, characterized in that:

in the unit region measuring step, the echo signals at each receiver coil unit are measured by making intervals between the plural parallel trajectories denser in the low spatial frequency region than intervals in the high spatial frequency region in each of the plural unit regions; and

in the sensitivity distribution data generating step, the sensitivity distribution data of each unit region and each receiver coil is generated independently, using the echo signals at each receiver coil unit in the low spatial frequency regions measured densely in the plural unit regions.

9. The magnetic resonance imaging method according to Claim 7 or 8, characterized in that:

in the sensitivity distribution data generating step, echo signals for sensitivity distribution data for each

receiver coil unit is generated by synthesizing echo signals at each receiver coil unit in the low spatial frequency regions of the respective unit regions for each receiving coil unit, echo signals for sensitivity distribution data for each unit region and each receiver coil unit is generated independently by converting the echo signals for sensitive distribution data for each receiver coil unit, and sensitivity distribution data of each unit region and each receiver coil unit is generated independently from the thus-generated respective echo signals for sensitivity distribution data for each unit region and receiver coil unit.

10. The magnetic resonance imaging method according to Claim 7 or 8, characterized in that:

in the sensitivity distribution data generating step, sensitivity distribution data of each unit region and each receiver coil unit is generated independently from echo signals at each receiver coil unit in the low spatial frequency regions in the respective unit regions, sensitivity distribution data of each receiver coil unit is generated by synthesizing the sensitivity distribution data of each unit region and each receiver coil for each receiver coil unit, and sensitivity distribution data of each unit region and each receiver coil unit is generated by converting the sensitivity distribution data of each receiver coil unit.

11. The magnetic resonance imaging method according to

Claim 7 or 8, characterized in that:

in the sensitivity distribution data generating step, echo signals for sensitivity distribution data for each receiver coil unit are generated by synthesizing echo signals at each receiver coil unit in the low spatial frequency regions in the respective unit regions for each receiver coil unit, sensitivity distribution data of each receiver coil unit is generated from the echo signals for sensitivity distribution data for each receiver coil unit, and sensitivity distribution data of each unit region and each receiver coil unit is generated by converting the sensitivity distribution data of each receiver coil unit.

12. The magnetic resonance imaging method according to Claim 6, characterized in that:

in the unit region measuring step, the echo signals at each receiver coil unit are measured by making intervals of the plural parallel trajectories in the low spatial frequency region denser than intervals in the high spatial frequency region in one of the unit regions; and

in the sensitivity distribution data generating step, for another unit region, sensitivity distribution data of each unit region and each receiver coil is generated using the echo signals at receiver coil unit in the low spatial frequency region measured densely in the particular one of the unit regions.

13. The magnetic resonance imaging method according to Claim 6, characterized in that the method comprises:

a step of measuring echo signals for sensitivity distribution data for each receiver coil unit in advance,

wherein, in the sensitivity distribution data generating step, sensitivity distribution data of each unit region and each receiver coil unit is generated using the echo signals for sensitivity distribution data for each receiver coil unit that has been measured in advance.

14. The magnetic resonance imaging method according to Claim 1, characterized in that, each time the unit region measuring step ends:

in the unit region image forming step, a unit region image is formed; and

in the entire image forming step, the entire image is formed from the unit region image and at least another one unit region image.

15. The magnetic resonance imaging method according to Claim 1, characterized in that:

the unit region measuring step and the unit region image forming step are performed in parallel;

in the unit region image forming step, the unit region image is formed using echo signals measured in a unit region measuring step before the current unit region measuring step; and

in the entire image generating step, the entire image is formed from the unit region image and at least another one unit region image.

16. The magnetic resonance imaging method according to Claim 9, characterized in that:

the unit region measuring step and the unit region image forming step are performed in parallel;

in the unit region image forming step, the unit region image is formed using echo signals measured in a unit region measuring step before the current unit region measuring step;

in the entire image forming step, after all unit region images including the unit region image are collected, k-space data of each unit region is generated by subjecting all the unit region images to inverse Fourier transform, entire k-space data is generated by synthesizing the k-space data of each unit region, and the entire image is formed by subjecting the entire k-space data to Fourier transform; and

the k-space data of each unit region is synthesized by converting the k-space data of each unit region to grid point data on a same coordinate system, and each converted k-space data is added or averaged for each grid point.

17. A magnetic resonance imaging apparatus, comprising:

signal receiving means for receiving echo signals from a subject;

measurement control means for measuring the echo signals

according to a specific sequence;

signal processing means for performing image reconstruction computation using the echo signals; and

overall control means for controlling the measurement control means and the signal processing means,

the measurement control means being provided with a sequence, according to which a measurement of echo signals corresponding to a unit region formed of plural parallel trajectories on a k-space is repeated by changing an angle of rotation of the unit region about an origin of the k-space,

the signal processing means including unit region image forming means for forming a unit region image from echo signals for each unit region, and entire image forming means for forming an entire image from respective unit region images,

wherein the magnetic resonance imaging apparatus is characterized in that:

the signal receiving means includes a multiple receiver coil formed by combining plural receiver coil units to receive the echo signals at each receiver coil unit;

the measurement control means measures the echo signals at each receiver coil unit by skipping one or more parallel trajectories in one or more unit regions; and

the unit region image forming means forms the unit region image from which aliasing is removed, from the echo signals at each receiver coil unit measured by skipping and sensitivity

distribution data of each unit region and each receiver coil unit.

18. The magnetic resonance imaging apparatus according to Claim 17, characterized in that:

the signal processing means further includes sensitivity distribution data generating means for generating sensitivity distribution data of each unit region and each receiver coil unit from the echo signals to correspond to the angle of rotation and a configuration of the multiple receiver coil.

19. The magnetic resonance imaging apparatus according to Claim 18, characterized in that:

the overall control means repeats, for each unit region, a measurement of echo signals corresponding to the unit region by the measurement control means, formation of the unit region image using the echo signals by the unit region image forming means, and formation of the entire image from the unit region image and another unit region image by the entire image forming means.

20. The magnetic resonance imaging apparatus according to Claim 18, characterized in that:

the overall control means repeats, in parallel, a measurement of echo signals corresponding to the unit region by the measurement control means, and the unit region image formation using echo signals acquired by a measurement of a unit region before the measurement of the current unit region

by the unit region image forming means, and formation of the entire image in the entire image forming means each time the unit region image and at least another one region image are collected.

FIG. 1

画像用の～:　IMAGE COORDINATE SYSTEM

115: SIGNAL COUPLING

117: FOURIER TRANSFORM

114-1 - 114-4: GRIDDING

109-1 - 109-4: INVERSE FOURIER TRANSFORM

208-1 - 208-4: MATRIX OPERATION

301: FIRST COORDINATE SYSTEM

302: SECOND COORDINATE SYSTEM

303: THIRD COORDINATE SYSTEM

304: FOURTH COORDINATE SYSTEM

FIG. 2

画像用の～:　IMAGE COORDINATE SYSTEM

115: SIGNAL COUPLING

117: FOURIER TRANSFORM ON IMAGE COORDINATE SYSTEM

301: FIRST COORDINATE SYSTEM

121: MEASUREMENT IN FIRST BLADE

128-1: FOURIER TRANSFORM ON FIRST COORDINATE SYSTEM

208-1: MATRIX OPERATION ON FIRST COORDINATE SYSTEM

109-1: INVERSE FOURIER TRANSFORM ON FIRST COORDINATE SYSTEM

114-1 - 114-4: GRIDDING TO IMAGE COORDINATE SYSTEM

302: SECOND COORDINATE SYSTEM

122: MEASUREMENT IN SECOND BLADE

128-2: FOURIER TRANSFORM ON SECOND COORDINATE SYSTEM

208-2: MATRIX OPERATION ON SECOND COORDINATE SYSTEM

109-2: INVERSE FOURIER TRANSFORM ON SECOND COORDINATE SYSTEM

303: THIRD COORDINATE SYSTEM

123: MEASUREMENT IN THIRD BLADE

128-3: FOURIER TRANSFORM ON THIRD COORDINATE SYSTEM

208-3: MATRIX OPERATION ON THIRD COORDINATE SYSTEM

109-3: INVERSE FOURIER TRANSFORM ON THIRD COORDINATE SYSTEM

304: FOURTH COORDINATE SYSTEM

124: MEASUREMENT IN FOURTH BLADE

128-4: FOURIER TRANSFORM ON FOURTH COORDINATE SYSTEM

208-4: MATRIX OPERATION ON FOURTH COORDINATE SYSTEM

109-4: INVERSE FOURIER TRANSFORM ON FOURTH COORDINATE SYSTEM

FIG. 4

4: SEQUENCER

9: GRADIENT COIL

10: GRADIENT POWER SUPPLY

11: HIGH-FREQUENCY GENERATOR

12: MODULATOR

14a: HIGH-FREQUENCY COIL

14b: HIGH-FREQUENCY COIL

16: QUADRATURE DETECTOR

18: MAGNETIC DISC

19: OPTICAL DISC

20: DISPLAY

FIG. 7a

FOURIER TRANSFORM

FIG. 7b

FOURIER TRANSFORM

FIG. 7c

MATRIX OPERATION

FIG. 9

TIME

301-1: FIRST BLADE DATA

302-1: SECOND BLADE DATA

303-1: THIRD BLADE DATA

304-1: FOURTH BLADE DATA

301-2: FIRST BLADE DATA

302-2: SECOND BLADE DATA

135-1 - 135-4: PARALLEL DEVELOPMENT PROCESSING

114-1 - 114-4: GRIDDING

137-1 - 137-3: IMAGE FORMATION

140-1 - 140-3: IMAGE

FIG. 10

TIME

301-1: FIRST BLADE DATA

302-1: SECOND BLADE DATA

303-1: THIRD BLADE DATA

304-1: FOURTH BLADE DATA

301-2: FIRST BLADE DATA

302-2: SECOND BLADE DATA

135-1 - 135-4: PARALLEL DEVELOPMENT PROCESSING

114-1 - 114-4: GRIDDING

137-1 & 137-2: IMAGE FORMATION

140-1 & 140-2: IMAGE